The Review of the manuscript "A spectral method for retrieving cloud optical thickness and effective radius from surface-based transmittance measurements**" by P. McBride submitted for publications to ACP.**

Cloud optical depth and effective radius are the most important cloud radiative parameters that strongly affect the Earth shortwave energy budget, a key interest in climate study. However, there are huge discrepancies between the retrieved values of cloud radiative parameters that use different ground-based observational and retrieval techniques. Indeed, due to a non-unique relationship between measured spectral zenith radiance and these cloud parameters, ground-based retrievals are very challenging.

This manuscript proposes a new retrieval technique that is based on spectral observations of zenith radiance between 1565 and 1634 nm. The authors claim that this technique avoids the ambiguity of other methods and provides droplet effective radius with lower uncertainties. As such, it's a very timely paper and definitely deserves to be published in ACP. However, I have some concerns and suggestions specified below.

Concerns and suggestions

- p. 1054, lines 25-28. I don't think that for the thicker clouds, the difference in uncertainty levels between 12.8% and 8.9% is significant enough to be mentioned in the abstract. For thinner clouds, at least for the dual wavelength method, the uncertainty level is misleading. The average retrieved effective radius of 17 um ±21% means that most of the retrieved effective radii are between 13 and 20 micron; this is incorrect if we look at Figs. 10c and 10d.

- p. 1056, lines 12-13. It is not quite true anymore. The AERONET cloud mode (see, http://aeronet.gsfc.nasa.gov/cgi-bin/type_piece_of_map_cloud and Chiu et al., 2010) can be mentioned here.

- p. 1057, lines 20-23. Rather than 3 wavelengths, it would be more accurately saying that, Kikuchi et al. (2006) used two dual-wavelengths: 1.02 and 1.6 um and 1.02 and 2.2 um. The authors of this paper didn't find much difference between them for water clouds. (With respect to Kikuchi et al., see also my comments to pages 1068, 1070 and 1071 below.)

- p. 1063, lines 24-25. Needs a reference. I would suggest:

Turner D. D., A. M. Vogelmann, R. T. Austin, J. C. Barnard, K. Cady-Pereira, J. C. Chiu, S. A. Clough, C. Flynn, M. M. Khaiyer, J. Liljegren, K. Johnson, B. Lin, C. Long, A. Marshak, S. Y. Matrosov, S. A. McFarlane, M. Miler, Q. Min, P. Minnis, W. O'Hirok, Z. Wang, and W. Wiscombe, 2007. Thin liquid water clouds: Their importance and our challenge. *Bulletin Amer. Meteor. Soc. (BAMS),* 88, 177-190.

- p. 1065, lines 17-18 and Fig. 1. USGS grass albedo is unrealistically large. I doubt that grass can reflect 70% in NIR. Please check!

- p. 1066, lines 10-11. Since a viewing angle was never mentioned, I assumed that it was nadir and zenith measurements. If appropriate and to avoid confusions, I'd call them zenith and nadir radiance; otherwise, indicate viewing angles.

- p. 1067, lines 3-9. Plots in Fig. 2 depend on SZA and surface albedo. They were never mentioned.

- p. 1068, lines 4-7. Need a reference here. I can suggest Rawlings and Foot, 1990 and/or Platnick, 2000.

- p. 1068, lines 25-27. The manuscript says that there is "*no* sensitivity to effective radius for optical thickness less than 10, with *some* sensitivity to effective radius for optical thickness between 20 and 40." This is the *key* statement describing the retrieval method. If this statement is true (and I believe, it is), how can one retrieve droplet effective radius using this method and report about the uncertainty of the retrievals? Also, I guess, this statement is not consistent with the results of Kikuchi et al. (2006). Instead of 515 nm they used 1020 nm. Does it help? I recommend discussing this issue more thoroughly. As a minor comment, please indicate SZA and surface albedo used for Fig. 3. To make Fig. 3b more informative, you might want to change the aspect ratio of the plot.

- p. 1070, lines 11-12. Again the manuscript says that "there is virtually *no* effective radius information under a cloud with optical thickness less than 10." See the previous comment.

- p. 1071, lines 25-28. The same. See the previous comment. Also, please indicate SZA and surface albedo used for Fig. 5.

- p. 1072, lines 17-28. To really understand and appreciate your proposed slope-transmittance retrieval algorithm, at least, a 2D plot of T(tau, reff) for the spectral region between 1565 and 1634 nm is desperately needed. This is the most innovative part of the paper but it is not sufficiently well explained and illustrated.

- p. 1073. Equation (9) is confusing. Explain it better or delete.

- p. 1075, lines 2-5. A reference is needed here. I can suggest Dutton et al. (2004JGR).

- p. 1076 and Fig. 10a. I didn't get why the retrievals for $5 \leq tau \leq 10$ are so good. How does it consistent with your previous statement that there is "*no* sensitivity to effective radius for optical thickness less than 10".

- p. 1077, lines 22-24. It's unclear to me. What is special in reff=16 um?

- p. 1078, lines 24-26. I don't think that the large uncertainties of the retrieved effective radius allow us to compare the validity of the assumptions behind Egs. (2) and (3).

- p. 1079, lines 6-7. What was the cloud base height for this case? It's a crucial information for comparing the effects of different FOVs.

- p. 1081, lines 16-17. 12.8% and 8.9% are obtained from standard deviations of non-Gaussian distributions as the ones in Fig. 10b. If this is true, they do not accurately characterize the uncertainty of the retrievals and I wouldn't emphasize that one of them is higher than another.

- p. 1081, lines 18- 19. The statement is too mild. At least, replace ‘higher’ with ‘much higher’.

- p. 1081, lines 24-27. This statement is not convincing for me.

- p. 1087. I would replace table 2 with just two values tau=46 for case (a) and 31-38 for case (b).

- p. 1093. Two green colors for tau=50 and 10. It is hard to distinguish them.

- p. 1098. What are those points that give reff>25 um for the 2wvl method in Fig 11c?

- p. 1101 and 1102. Figures 14 and 15 are too busy. It is hard to get any information from them.

- p. 1103 and 1104. To better see the variability, I would recommend to change the aspect ratios of these plots.